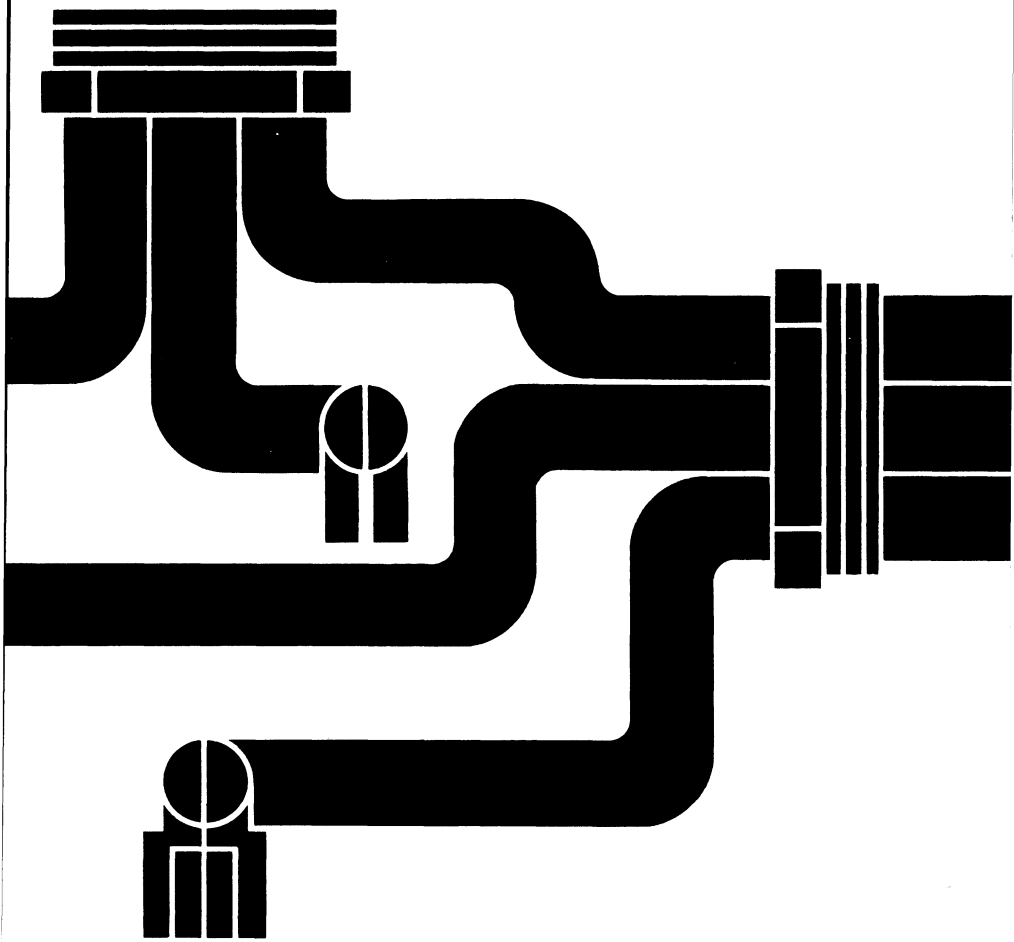
# Standby Electric Power Equipment for the Farm and Home



United States Department of Agriculture

*PREPARED BY* Science and Education Administration

Farmers' Bulletin Number 2273

**Acknowledgments**

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This publication supersedes Leaflet 480, "Standby Electric Power Equipment for the Farm," that was issued in October 1960.

December 1980



For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402

# Standby Electric Power Equipment for the Farm and Home

by H. B. Puckett[1]

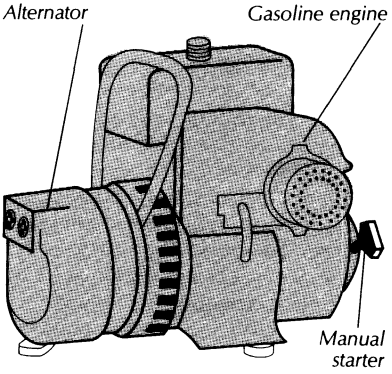
Electricity is essential to farm and ranch operations and to family life. Milk coolers, water pumps, household furnaces and refrigerators, ventilating systems, and other vital equipment for home and livestock operations require continuous electric power.

Storms, accidents, or failure of power-supplying equipment at times cause power outages. An outage that lasts long can lead to serious problems, such as frozen water pipes, spoiled food, and loss of production —even the life of confined livestock.

With standby electric power service, you can keep your essential electric equipment operating during power outages. This "insurance" can help you avoid inconvenience and possible financial loss. To provide standby service, you need an alternator to produce 60 hertz (cycles per second) of alternating electric current at 120/240 volts, an engine to run the alternator, and a transfer switch to safely control the electric current.

## Alternator

Standby alternators are either engine-driven or tractor-driven. Engine-driven alternators are either automatically or manually started; they are either stationary or portable. If you can turn off or disconnect some equipment when standby power is needed, you may be able to use a small, manually controlled, engine-driven alternator instead of a larger and more expensive model.




*Portable alternator with manually started engine*

Tractor-driven alternators are manually started; they are either stationary or portable, with some units mounted on tractors. These alternators are driven by either a belt or power-takeoff (PTO) from a tractor.

## Voltage rating

Your alternator should provide the same type of power at the same voltage level as that supplied by your powerlines.

Most farms would need 120/240 volt, single-phase, three-wire alternators. However, alternators with voltage ratings of 115/230 or 120/208 can be used if they are correctly connected and operated. A 120/208-volt alternator is actually a three-phase unit for four-wire service. For single-phase power, one 208-volt lead is left idle, and two leads and the neutral wire are used. Do not exceed the phase-current rating of three-phase alternator. Single-phase equipment will operate satisfactorily when powered by the three-phase alternator, but motors may be sluggish in starting, and their starting

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torque may be reduced because of the lower voltage.

Some farms now have three-phase electric power. If your farm has three-phase power, ask your power supplier or alternator dealer what type of alternator you should use.

Do *not* use direct-current generators to power alternating-current systems. Do *not* use two-wire, single-phase generators to power 120/240-volt, three-wire systems.

**Size rating**

Alternators are rated by their power output, measured in kilowatts or watts (1 kilowatt equals 1,000 watts). Some alternators may also be rated in kilovolt-amperes or volt-amperes. You can find their power outputs in kilowatts by multiplying kilovolt-ampere rating by 0.8. For watts, multiply volt-ampere ratings by 0.8. The power factor for most farm and home inductive loads (motors) is 0.8, and the effective power ratings of the alternator is reduced by this factor.

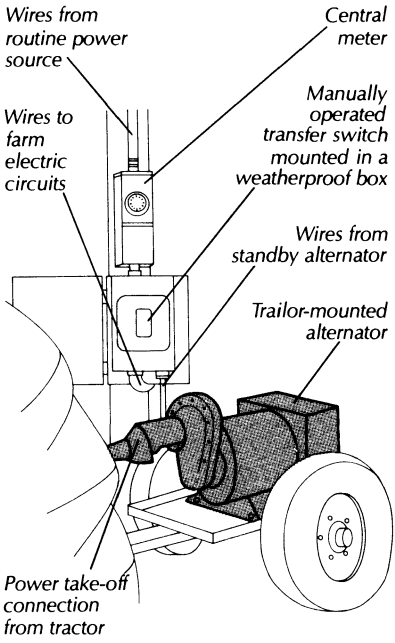
The kilowatt (or watt) rating, given on the alternator's nameplate, is not necessarily the maximum output. Some alternators have an overload capacity of as much as 100 percent, although this is generally limited to short, intermittent periods.

Some equipment does indicate overload capacity. When you see two kilowatt ratings on the nameplate, the larger number is the short-time capacity; the smaller is the continuous output rating. For example, 20/10000 means 10,000 watts of continuous power and 20,000 watts of short-time (or overload) power.

In selecting an alternator, you should consider its capacity for overloads and its motor-starting capability. The alternator must be capable of starting the largest motor that is to be operated by the standby electric power unit.

**Alternator size**

The size of alternator you need depends, in part, on whether you will be operating all or only part of your equipment at the same time.




*Tractor-driven alternator hooked to electric system*

If your system is designed to start automatically, you have no choice: you must use an alternator with a large enough capacity to operate all of your equipment.

But most farmers need to operate only part of their equipment with standby power. If this is true in your case, use the following steps to figure your total needs for power load and size. (Motors require from three to five times more current for starting than for continuous running. Account for that initial surge in power. Remember, by starting motors *one at a time,* you may use a small alternator.)

The *first* step is to decide what equipment you need to operate during power outages. Consider also equipment you may add later.

*Second,* check the horsepower ratings and current demand of the motors of equipment you will need

**Table 1** — Wattage and horsepower requirements of typical farm and house equipment

| Kind of equipment | Typical size | |
|---|---|---|
| | *Watts* | *Horse-power* |
| **Farm equipment:** | | |
| Milking machine | 800-5,000 | ½-5 |
| Bulk milk cooler | 1,500-1,200 | 1-12 |
| Water pump | 500-2,500 | ⅓-2 |
| Water heater | 1,000-10,000 | — |
| Milking parlor heater | 2,000-10,000 | — |
| Space heater | 1,000-5,000 | — |
| Ventilation fans | 300-800 | ⅙-½ |
| Silo unloader | 2,000-7,500 | 2-7½ |
| Electric fence | 7-10 | — |
| Feed grinding | 1,000-7,500 | 1-7½ |
| Feed mixing | 800-1,500 | ½-1 |
| Feed conveyor | 800-5,000 | ½-5 |
| Gutter cleaner | 3,000-5,000 | 3-5 |
| Infrared lamp | 250 | — |
| Yard light | 100-500 | — |
| Shop tools | 300-1,500 | ⅙-1 |
| **Essential home equipment:** | | |
| Refrigerator | 400-800 | ¼-½ |
| Freezer | 600-1,000 | ¼-½ |
| Furnace stoker | 400 | ¼ |
| Furnace oil burner | 300 | ⅙ |
| Furnace blower | 400-600 | ¼-½ |
| Electric heater | 600 and up | — |

| Kind of equipment | Typical size | |
|---|---|---|
| | *Watts* | *Horse-power* |
| **Optional home equipment:** | | |
| Toaster | 1,200-1,500 | — |
| Electric skillet | 1,150-1,500 | — |
| Mixer | 150 | — |
| Coffeemaker | 1,000-1,500 | — |
| Electric iron | 500-1,500 | — |
| Electric range | 3,000-10,000 | — |
| Electric clothes dryer | 500 plus 4,000 for heater | ⅙ |
| Window air-conditioner | 1,000-2,500 | ½-2 |
| Central air-conditioner | 2,000-5,000 | 2-5 |
| Electric fan | 75-300 | — |
| Water heater | 1,000-5,000 | — |
| Kitchen ventilator | 150 | — |
| Water pump | 800-2,500 | ½-2 |
| Television | 200-600 | — |
| Washing machine | 400- | ¼-½ |
| Dishwasher | 300 plus 1,500 for heater | ⅙ |
| Sewing machine | 200-500 | — |
| Sweeper | 400-1,500 | ¼ and up |

Source: McCurdy, Joseph A., "Standby equipment for electric power interruptions," Pennsylvania State University, University Park, Pa., 12 pages, undated.

to operate (their nameplates should show those ratings).

*Third,* calculate the wattage required to start and operate each motor, based on its horsepower or wattage requirements. Power needs of typical equipment are shown in table 1. Table 2 lists the power needs for starting and running various sizes of motors.

Start with your largest motor. Add the *running* watts of this motor to the *starting* watts of the second largest motor. Next, add the *running* watts of the first two motors to the *starting* watts of the third motor.

Continue your calculations until you've added all motors. You will need an alternator with a starting capacity equal to this total. After all the motors are running, excess power will be available for other electric equipment, such as appliances and lamps.

*Fourth,* check your calculations with your local Extension agent, power supplier, or alternator dealer before you purchase an alternator.

**Engine or Tractor**

Now that you know what size of alternator you need, you can select the proper size of engine to run the alternator. The engine or tractor should develop 2.5 horsepower for each kilowatt of electric power produced by the alternator. (This will permit production of rated kilowatts at about 80 percent of the engine's power, and it assumes satisfactory operation after the engine has been used 800 or more hours with proper maintenance.) For alternators larger than 75 kilowatts, 2 horsepower for each kilowatt is adequate. That is, an engine will need at least 150 horsepower to power a 75-kilowatt alternator.

Another factor to consider is the type of engine. Aircooled engines,

**Table 2** — Starting and running (full-load) power requirements for various sizes of single-phase motors

| Motor horsepower | Approximate full-load amperes at 240 volts | Watts required — To start | Watts required — To run |
|---|---|---|---|
| 1/6 | — | 600-1,000 | 215 |
| 1/4 | — | 1,200 | 300 |
| 1/3 | — | 1,600 | 400 |
| 1/2 | 4.9 | 2,300 | 575 |
| 3/4 | 6.9 | 3,345 | 835 |
| 1 | 8 | 4,000 | 1,000 |
| 1 1/2 | 10 | 6,000 | 1,500 |
| 2 | 12 | 8,000 | 2,000 |
| 3 | 17 | 12,000 | 3,000 |
| 5 | 28 | 18,000 | 4,500 |
| 7 1/2 | 40 | 28,000 | 7,000 |
| 10 | 50 | 36,000 | 9,000 |

Source: McCurdy, Joseph A., "Standby equipment for electric power interruptions," Pennsylvania State University, University Park, Pa., 12 pages, undated.

which are generally low in cost, are recommended for alternators up to 15 kilowatts in size. Larger alternators require liquid-cooled engines.

**Transfer Switch**

A transfer switch is an essential part of standby electric power equipment. The National Electric Code and electric power suppliers require that a standby generator be properly connected to the electric system with a transfer switch to prevent any accidental interconnection of the alternator and your supplier's powerlines. Otherwise, feedback of your alternator's current onto the powerlines could endanger the life of anyone working on the lines and would probably destroy your alternator through a short circuit. The transfer switch also prevents accidental reenergizing of your equipment, which could destroy your standby alternator when regular power is restored.

For single-phase power, the transfer switch should be a double-pole, double-throw type. For three-phase power, you'll need a three-pole, double-throw type. Either type should have an enclosure that will protect the switch in its environment. Remember, this is your main power disconnecting switch.

Your switch must be sized according to the highest rating of any of your equipment or electric service. Common sizes are 100, 200, and 400 amperes.

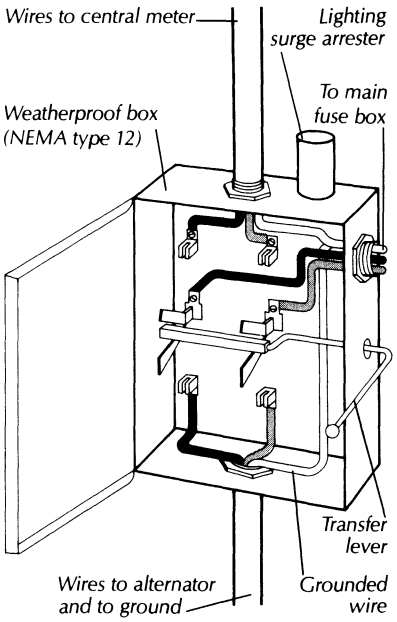
Automatic switches, which are part of a control panel, are used when standby service is automatic. Otherwise, manually operated switches are used.

**Accessory Equipment**

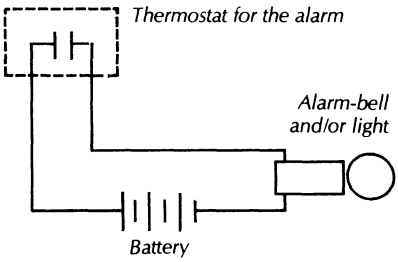
A *pilot lamp* (neon type) connected to the power supplier's lines between the meter and the transfer switch helps you tell when regular power has failed and when it has been restored.

You can choose from many types of *alarms* that warn against almost any undesirable situation. An inexpensive power-off alarm can easily be plugged into an electric outlet in your bedroom. Whether your needs call for a simple or sophisticated system, be sure to provide a convenient way to regularly test the alarm.

A *tachometer* or *frequency meter* can be used to measure the speed of your alternator. (The speed of rotation determines the frequency of the




*Wiring of a typical transfer switch for manual operation*




*A simple alarm using a thermostat to sense cooling that occurs after power failure*

alternating current produced.) A tractor tachometer can be used if you account for pulley sizes or for PTO gear ratios. In general, 540 revolutions per minute (r/min) of the PTO shaft will supply 60 hertz of current. A *voltmeter* may come attached to your alternator. If not, you should use one to help you regulate the alternator's voltage.

**Installation**

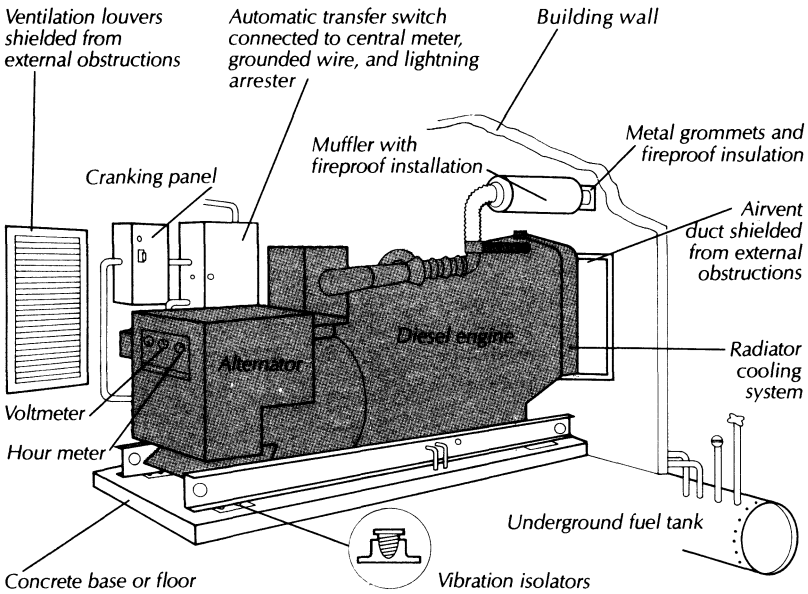
Wiring and equipment must be correctly installed to meet the National Electric Code, your local ordinances, and the requirements of your power supplier. Inspection by the power supplier and local electrical inspector may be required; it is certainly recommended.

After consulting the power supplier, the transfer switch may be installed in the wiring system between the power supplier's meter and the service entrance (main fuse box).

The alternator should be set up in a safe, dry place within 25 feet (8 m) of the transfer switch, preferably within sight of the switch. The alternator should be mounted on a trailer or bolted to a permanent, reinforced concrete base at least 6 inches (15 cm) thick.

If you use a tractor-driven alternator, select a location where your tractor can easily be alined and attached to the alternator. Be sure the tractor is stored where it is accessible even in blizzards and other severe weather, the most likely times for you to need the standby power systems. Mark out a floor guide for the tractor. This guide will help you quickly and accurately position and aline the tractor.

Make sure the PTO shaft or other drive mechanism is stored with or attached to the alternator. If your alternator is mounted on a trailer, the alternator must be tightly secured to the mounting base so it will with-




*Typical indoor installation for a large diesel-powered alternator*

stand torque stresses and not spin around the PTO when it is under full load.

Cover all alternator openings with ¼-inch (0.6-cm) galvanized wire mesh to prevent damage by rats and mice. Clean the mesh of dust and trash accumulations that will restrict cooling airflow through the alternator.

If the standby unit is indoors, be sure the ventilation is adequate. The engine of a 5-kilowatt alternator produces almost as much heat as a house furnace.

Air inlets and outlets should each be open at least a half square-foot (0.046 $m^2$) for each kilowatt of alternator capacity. Exhaust fumes must be vented to the outside; you can use an exhaust-pipe extension or flexible metal tubing. The engine's exhaust pipe and connecting tubing must be at least 6 inches (15 cm) from combustible material, because the exhaust pipe becomes quite hot during operation.

If the unit is outdoors, shelter it from the weather. Do *not* cover it with moisture-holding plastic sheeting. The shelter must be well ventilated and permit easy access to the equipment. Protect the engine cooling systems from fine blowing snow, dust, or other material that can block the air intake or exhaust gas pipes.

**Operation**

Use your manufacturer's manual. Study and follow the instructions for running your equipment.

If your unit is automatic, it should immediately start when regular power fails. It should stop when regular power is restored.

If your unit is manually controlled or tractor-driven, proceed as follows:

*One,* call your power supplier and report your power failure.

*Two,* turn off or disconnect *all* electric equipment.

*Three,* place the tractor or engine in position. Connect the drive belts or PTO.

*Four,* start the engine or tractor. Bring the alternator up to its proper speed (1,800 or 3,600 r/min). A tractor should run at two-thirds to full engine speed (throttle). Maximum torque is produced at about two-thirds of the rated speed and will provide a more stable alternator speed under varying loads. At less than two-thirds throttle, it may not have enough power, and the governor action will be much less exact.

*Five,* check the voltmeter and frequency meter. The voltmeter should register at least 230 volts for 120/240-volt service, or 115 volts for 120-volt service. The frequency meter should read 60 hertz, plus or minus 3 hertz, at maximum. Do not increase alternator speed to more than 1,800 or 3,600 r/min under normal load to raise the voltage. It will *not* increase the electric power output, and it can cause problems with your motors and other frequency sensitive equipment. (Your electric clocks will run faster or slower in proportion to the variance of standby power from 60 hertz.)

*Six,* put the transfer switch in the alternator's operation position.

*Seven,* connect the electric load. Start the largest motor first, adding other loads when each succeeding motor reaches its full operating speed. Do *not* add the loads too quickly. If the alternator stops, repeat steps two, four, five, six, and seven.

*Eight,* check the voltmeter often to make sure you're not overloading the alternator. If voltage falls below 200 for 120/240-volt service, or 100 for 120-volt service, turn off some of the electric equipment to reduce the load.

*Nine,* when regular power is restored, move the transfer switch into the regular power source's position. Then stop the standby unit. Turn on electric loads as usual.

**Maintenance**

Follow the instructions in your alternator manufacturer's manual. Test operate engine-driven units (under load) at least once a month.

Check for fuel leaks. Replace or use the fuel supply periodically to prevent moisture condensation in the tank, gum accumulation in the carburetor, or fuel deterioration (loss of volatile components).

**Precautions**

- Test your standby unit in advance — before an emergency occurs — to make sure it works and to familiarize yourself with the procedure.
- Don't use your standby unit, if farm wiring has been damaged or is defective, until you remove the defective circuit from the system.
- If wind, ice, or an on-farm accident caused the power outage, your farm or home wiring may need to be repaired before you use the standby unit.
- Keep flashlights or lanterns handy so that you have light if you need it.

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